On the Edge of the Creative Process:
An Analysis of Human Figure Animation as a Complex Synthesis Task.

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1. INTRODUCTION

The process of animating human figures with a computer is a challenging task, both because the specification, representation and control of human movement is complex, and because animation as a human creative process is not well understood. Over the past six years, we have developed the *LifeForms* system, a computer application to animate human figures [2]. During this period, users of the system have played an active part in the design cycle: their feedback has lead to a better understanding of the interface for the representation of movement, while observing some of the users has given us insights into how the creative process can be supported by the system.

In this paper, we discuss new work in progress to analyze the creative process in terms of its hierarchical structure, alternate views and use of knowledge. These components of the creative process were first explored in a pilot experiment studying how dancers use *LifeForms* to create a given movement sequence. In this experiment, a videotape showing simple human movement sequences was provided as a design task for the subjects. The objective was to explore the functionality of the interface. However, by strictly replicating movement patterns in *LifeForms* rather than creating their own, individual sequences, the subjects' performance gave little information on the structure of complex synthesis tasks. Subsequently, a new experiment was designed to more closely explore the creative process. This time, the task involved using simple animated objects (shapes) as the basis for the movement composition assignment. These shapes provide the subjects with a higher level of abstraction than the video sequences in the previous design experiment, thus permitting them to interpret the animated shapes into their very own concrete ideas for movement to be realized with *LifeForms*.

2. THE CREATIVE PROCESS

It is only by understanding how humans carry out complex design tasks that we will understand the requirements for a human figure animation system and for its interface. We assume the design process to be both interactive and iterative, relying on previous knowledge, alternate views, expertise and new impulses which develop within a hierarchical structure of ideas at different levels of abstraction.

2.1 The Hierarchical Structure

The hierarchical process [6] begins with a simple sketch, or mere idea, in the mind of the artist. This is the highest level of conceptualization of shape, energy flows and timing of the composition. Because it is inherently an abstraction, this level is most difficult to represent. Once a concept is formed, the composition becomes successively more concrete. Details are added and the process moves onto lower and lower levels, the lowest being the complete physical realization of dance or animation. *LifeForms* supports the hierarchical structure and iterative refinement by providing specification of motion at different levels of abstraction; for instance, low-level fine-tuning of a movement, inverse kinematics, procedural control, as well as temporal and spatial arrangement of movement sequences are possible [2].

2.2 Alternate Views

The act of discovery or creation often occurs when different views or distinct representations are recognized as depicting the same object, idea, or entity [5]. *LifeForms* allows a user to flexibly move between several different views: a *temporal* view, a *spatial* view, and a *sequence* editor for movement creation and modification.

2.3 Use of Knowledge

Composing involves a combination of one's internal knowledge and external knowledge stored in the system. *Internal* knowledge refers to the expertise of a choreographer which is based on prior training in the physical kinesthetic experience of dance, movement and choreography. *LifeForms* provides various types of *external* knowledge [2], such as using inverse kinematics, procedural control, or predefined movement sequences which can be stored in libraries, retrieved, and reused flexibly. This way, our interface has evolved to be an intuitive, visual, transparent, non-numerical tool to link creative knowledge of the animator with the knowledge built into the system.

3. THE SHAPES EXPERIMENT

3.1 Motivation

In the first pilot experiment, several dancers were asked to recreate a video scene where three live human subjects performed three different but simple movement patterns: a walking sequence, a star jump, and a sitting sequence. The task was designed in such a way as to encourage the subjects to utilize all of the main tools provided by *LifeForms*. As a result, this design task was suitable for evaluating the interface. However, the task limited the creativity of the dancers as they were merely replicating a video scene.

In light of the first experiment, a new design task was developed, one more conducive to exploring creativity on the part of the choreographer. This new design task uses simple, animated shapes to suggest human movement at an abstract level to the subjects.

3.2 The Design Task

Three shapes were animated to give subjects a movement idea: a purple cube, a blue pyramid, and a turquoise sphere. Starting in a triangular configuration, with the cube in the upper left, the pyramid in the upper right, and the sphere at the bottom centre of the screen, the three shapes become alive. First, the cube and pyramid spin on the spot around the y axis followed by a single flip around the z axis. Then they translate to the bottom of the screen, while the sphere zig-zags around the screen. The animation ends with the three shapes in another triangular configuration, only this time the cube and pyramid are at the bottom of the screen and the sphere in the middle.

Based on the animation of the simple shapes, a dancer composed a piece using *LifeForms*. The subject was encouraged to verbalize her intentions and actions. The experiment was video-taped and limited to one hour.

3.3 Results

Results of the first experiment reveal that a visual representation of the task is more suitable than a written presentation because the latter may influence the order in which the task is implemented which in turn would affect how the subject executes the task.

Both experiments show that methodologies used in attaining the final composition appear to be an iterative, hierarchical process. In the shape experiment, the development of the composition first began with a mere idea in the mind of the composer based on internal knowledge. For example, one subject represented each of the three shapes with a *LifeForms* figure. The spatial configuration of the three figures corresponded to the initial triangular position and the subsequent motion of the shapes. Another subject interpreted the shape animation as one figure with the sphere being the body, and the cube and pyramid depicting the hands. She expressed the rotations of the cube and the pyramid as the twirling of the hands. Although the subjects viewed the shapes differently, their approach in implementing their thoughts on *LifeForms* reflected the hierarchical nature of the creative process; that is, they frequently switched between the spatial view for experimenting with movement ideas, and the sequence editor for fine-tuning motion.

The experiments also demonstrate that the subjects take advantage of all the views available in *LifeForms*. Moreover, they moved back and forth between them. By focusing on one view at time while choreographing, the number of independent variables is reduced, thus simplifying the complexity of the assignment at hand. For instance, one subject viewed various single sequences in the sequence editor, but it was not until she viewed the animation in the spatial view that she realized the sequences did not complete simultaneously; this timing problem was adjusted in the temporal view. Thus, the various views provide different perspectives and allow the subjects to concentrate on a particular aspect of the task.

All subjects made use of external knowledge by browsing through the movement libraries in order to find sequences to express their initial concepts. Even when no library sequence completely reflected their movement idea, the subjects chose the closest sequence and modified it rather than creating a new sequence from scratch.

4. CONCLUSION

The shape experiment demonstrates that creative processes such as movement composition are hierarchical, utilize alternate views and rely on different kinds of knowledge. Computer applications for these tasks must support these elements functionally, and in their interfaces, to become meaningful to the animator's way of creating, visualizing, thinking, structuring and juxtaposing movement ideas.

The shape experiment also shows that when the subjects were given movements of simple shapes, they individually conceived more complex human movement patterns based on their experience and creativity. We believe that the essence of the movement is suggested by the shapes, but further investigation is necessary to explore the fundamental elements of representing human motion [4].

Our plan is to extend the experiments by making use of protocol analysis [1] and a video annotation and analysis system [3]. Results should provide new input into the future development of *LifeForms*, evolution of the interface, and insight into the creative process.

5. REFERENCES

1. Adelson, B. "Uncovering How Designers Design; Cognitive Modeling: Explaining and Predicting How Designers Design", *Research and Engineering Design*, 1, 1, 1989.
2. Calvert, T.W et al. "The Evolution of an Interface for Choreographers", *Proc. InterCHI'93*, Amsterdam, April 1993.
3. Harrison, B.L., Baecker, R. "Designing Video Annotation and Analysis Systems", *Proc. Graphics Interface'92*, May 1992, Vancouver, pp.157-166.
4. Johansson, G. *Perception and Psychology*, 14, 1973, pp. 201-211.
5. Koestler, G. *The Act of Creation*, 1964.
6. Simon, H.A.: *The Sciences of the Artificial*, MIT Press, Cambridge, MA, 1969.